Feasibility Assessment for Biomass Heating Systems
Nondalton, Alaska

FINAL REPORT - 7/26/2013

COFFMAN ENGINEERS

800 F Street, Anchorage, AK 99501
p (907) 276-6664 f (907) 276-5042

Tony SlatonBarker, PE and
Lee Bolling, CEA

Contents

Appendices

Abbreviations

ACF	Accumulated Cash Flow
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
AEA	Alaska Energy Authority
AFUE	Annual Fuel Utilization Efficiency
AHU	Air Handling Unit
ARCH	Architectural
B/C	Benefit / Cost Ratio
BAS	Building Automation System
BTU	British Thermal Unit
BTUH	BTU per hour
CCF	One Hundred Cubic Feet
CEI	Coffman Engineers, Inc.
CFM	Cubic Feet per Minute
CIRC	Circulation
CMU	Concrete Masonry Unit
CRAC	Computer Room Air Conditioning
CWCO	Cold Weather Cut Out
DDC	Direct Digital Control
ΔT	Delta T (Temperature Differential)
ECI	Energy Cost Index
ECM	Energy Conservation Measure
EF	Exhaust Fan
Eff	Efficiency
ELEC	Electrical
EPDM	Ethylene Propylene Diene Monomer
EUI	Energy Utilization Index
F	Fahrenheit
ft	Feet
GPM	Gallons Per Minute
HP	Horsepower
HPS	High Pressure Sodium
HVAC	Heating, Ventilating, and Air-Conditioning
IESNA	Illuminating Engineering Society of North America
in	Inch(es)
IPLC	Integrated Power and Load Circuit
IRC	Internal Revenue Code
kBTU	One Thousand BTUs
kWh	Kilowatt-Hour
LED	Light-Emitting Diode
MBH	Thousand BTUs per Hour
MECH	Mechanical
MH	Metal Halide
O&M	Operations and Maintenance
MMBTU	One Million BTUs
P	Pump
PC	Project Cost
PF	Power Factor

R	R-Value
PH	Phase
SC	Shading Coefficient
SAT	Supply Air Temperature
SF	Square Feet, Supply Fan
TEMP	Temperature
U	U-Value
V	Volts
VFD	Variable Frequency Drive
W	Watts

List of Figures

List of Tables

I. Executive Summary

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems at the Tribal Office Building, Community Building and St. Nicholas Church in Nondalton, Alaska. In the study, the proposed biomass system determined to be the most practical and cost effective for each building is a high efficiency wood stove. A wood boiler system, such as a Garn, was not evaluated due to high mechanical integration costs, limited available space and system complexity.

The results of the economic evaluation for all three buildings are shown below. It was found that installing a high efficiency wood stove at each building is economically justified, due to the fact that the benefit to cost ratio of each option is greater than 1.0. The Tribal Office Building and Community Building are the most cost effective projects. St. Nicholas Church has a longer payback time due to its limited operation and relatively low heating oil consumption.

Economic Analysis Results			
Building	**Tribal Office Building**	**Community Building**	**St. Nicholas Church**
Project Capital Cost	($12,120)	($12,120)	($12,120)
Simple Payback	2.9 years	3.2 years	13.8 years
Present Value of Project Benefits (20 year life)	$285,647	$260,496	$65,573
Present Value of Operating Costs (20 year life)	($179,651)	($164,047)	($41,937)
Benefit / Cost Ratio of Project (20 year life)	8.75	7.96	1.95
Net Present Value (20 year life)	$93,876	$84,330	$11,516
Year Accumulated Cash Flow is Net Positive	First Year	First Year	First Year
Year Accumulated Cash Flow > Project Capital Cost	2.8 years	3.0 years	10.0 years

Table 1 – Economic Evaluation Summary

II. Introduction

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems for three buildings in Nondalton, AK. The three buildings are the Tribal Office Building, the Community Building, and St. Nicholas Church. The locations of the buildings are shown in Figures 1 and 2.

Fig. 1 – Nondalton, Alaska – Google Maps

Fig. 2 – Nondalton Buildings Evaluated – Google Maps

III. Preliminary Site Investigation – Tribal Office Building

Building Description

The Tribal Office Building is a 2,200 SF two story building that was built in 1991. It was originally used for temporary housing until it was renovated in 2011 into office space. The next planned renovation will involve finishing the remaining part of the second floor, which is currently inaccessible. It is used by four or five office staff during the weekdays during working hours and occasionally during the weekend. It is typically used approximately 50 hours per week. No energy audit has been conducted at the building.

Existing Heating System

The heating system for the Tribal Office Building includes one Toyostove and one Monitor stove, each located on the first floor. The second floor has no installed heating system and second floor offices utilize individual electric space heaters for additional heat. Two electric space heaters were observed on the second floor during the site visit. There is no central boiler and no boiler room in the building.

The Monitor stove (model 2400, 37,200 BTU/hr output) serves the first floor conference room and the Toyostove (model Laser 73, 40,000 BTU/hr output) serves the first floor office space. The heaters appear to be in fair working order and the age of the units is unknown. There is no routine maintenance of the heaters. One 300 gal heating oil tank serves the Monitor and a 55 gal drum serves the Toyostove. Each tank is located outside the building adjacent to the wall where each heater is located. No spill containment is present around the tanks. Fuel in the tanks is used for heating only.

Domestic Hot Water

Domestic hot water is used only for hand washing in the building's two bathrooms. A shower exists in the second floor bathroom but is never used. There are two electric resistance hot water heaters; with one serving each bathroom. The first floor bathroom has a 30 gal Reliance electric hot water heater that is currently disconnected and not in service. A 50 gal Richmond electric hot water heater serves the second floor bathroom.

Building Envelope

The walls of the building are 2x6 wood stud construction that are estimated to have R-19 fiberglass batt insulation. The roof is a cold roof with a vented attic space, with an unknown amount and type of insulation because it could not be accessed. It is estimated that the roof insulation is R-25 fiberglass batt insulation. The windows are double pane and there are unheated arctic entries for each of the two entrances.

Available Space

There is space inside the building for a residential style wood stove. However, an addition would be needed to house a larger Garn wood boiler type system.

Street Access and Fuel Storage

The building is situated along a gravel road and a truck can easily access the front and sides of the building. There is adequate space around the building for a wood storage shed and/or wood boiler building. Brush may have to be removed and additional gravel may be necessary to situate the new structures.

Building or Site constraints

The site is flat with no significant site constraints.

Biomass System Integration

The building currently has no hydronic piping, boiler, or fin-tube baseboard. Thus, to implement a wood fired boiler system, new hydronic piping and baseboards would need to be installed, adding significant expense. A residential style high efficiency wood stove could easily be installed in the building.

Biomass System Options

There are two options for incorporating biomass systems into the Tribal Office Building:

1) A high efficiency wood stove, or
2) A high efficiency wood boiler system in a detached building.

Both systems would require a person to load and fire the wood heating systems by hand.

A residential style high efficiency wood stove would be the most cost effective and lowest tech option. Wood heating with wood stoves is standard with most homes in Nondalton for auxiliary and back-up heating. The wood stove would be easy to operate and would require minimal maintenance compared to a wood boiler system. The wood stove would be used to provide a base heat load for the building during occupied times. Occupants would fire the stove regularly to provide as much heating oil displacement as they wish. The existing Toyostove and Monitor stove would still be used to make up for additional required heating during occupied times and as heaters when the building is unoccupied. For this study, a Blaze King Classic high efficiency wood stove with an output of 48,065 BTU/hr for 12 hours was selected as the proposed biomass system to evaluate.

The second option is a wood fired boiler system, such as a Garn, which will be more expensive and require more maintenance than a wood stove. A wood fired boiler can be loaded and fired in batches, which heats up a large volume of water for space heating. This allows a wood fired boiler to be loaded less times throughout the day than a wood stove, which would need a higher loading frequency. The wood fired boiler system would be located in a detached boiler building and heating pipes would be routed to the building. Pre-insulated heating pipes are typically below grade if the boiler building is a significant distance from heating load. Due to the significant expense of retrofitting the building with a hydronic system and the increased complexity of a wood boiler system, this option was not evaluated in this study. Also, there appears to be limited maintenance personnel available in the community to maintain a Garn type system.

IV. Preliminary Site Investigation – Community Building

Building Description

The Community Building is a 2,000 SF one story building that was built in 1995. It is used for office space and for holding large community events. It has a large main room and a large kitchen with a food storage room. The building had window, door and air sealing improvements completed in 2011, as part of recommendations from an energy audit. The energy audit for the building was not provided to us.

Additional interior renovations are planned but there is currently no funding or timeline for the projects. The building has two office workers that use the building for the typical 40 hour work week. The building is also used for large community events during the weekdays and weekends. Meetings, classes and potlucks can range from 10 to 100 people. It is estimated that the building is occupied 50 hrs per week.

Existing Heating System

The community building is heated by a single Monitor stove located in the main room. There is no boiler or boiler room. The stove is a Monitor 441, direct vented heating oil furnace with an output of 43,000 Btu/hr. The unit has its own controls and thermostat. There is no routine maintenance that is performed on the unit. The Monitor stove appears to be in good working order. The age of the unit is unknown. One 500 gal heating oil tank is located adjacent the exterior wall near the Monitor stove. The tank is surrounded by a chain link fence and enclosed by a wood structure. No spill containment is present around the tank and fuel in the tank is only used for heating.

Domestic Hot Water

Domestic hot water is used only for hand washing in the single bathroom and for washing in the kitchen. No shower or laundry facilities exist in the building. There is one 30 gal electric water heater located in the food storage room by the kitchen.

Building Envelope

The walls of the building are 2x6 wood stud construction that are estimated to have R-19 fiberglass batt insulation. The roof is a cold roof with a vented attic space, with an unknown amount and type of insulation because it could not be accessed. It is estimated that the roof insulation is R-25 fiberglass batt insulation. The windows are new double pane windows. There is an unheated arctic entry for the main entrance.

Available Space

There is space inside the building for a residential style wood stove. However, an addition would be needed to house a larger Garn wood boiler type system.

Street Access and Fuel Storage

The building is situated along a gravel road and a truck can easily access the front of the building. However, there is limited space around the sides and back of the structure which could make wood storage an issue. Wood storage may be able to be done on the west side of the building.

Building or Site constraints

The site is on a south facing hill that slopes sharply to the lake. There is also a large satellite dish and GCI communication conex located to the east of the building. Due to these factors, there is no obvious space for a detached boiler building to house a wood fired boiler. The west side of the building may have space, but would require brush and tree clearing and significant fill to level the space for construction.

Biomass System Integration

The building currently has no hydronic piping, boiler, or fin-tube baseboard. Thus, to implement a wood fired boiler system, new hydronic piping and baseboards would need to be installed. A residential style high efficiency wood stove could easily be installed in the building.

Biomass System Options

There are three options for incorporating biomass systems into the community building:

1) A high efficiency wood stove,
2) A high efficiency wood boiler system in a detached building, or
3) A large central plant wood boiler system that would serve the Community Building, Clinic Building, Ambulance Building, St. Nicholas Church and potentially other buildings in close proximity.

All systems will require a person to load and fire the wood heating systems by hand.

A residential style high efficiency wood stove would be the most cost effective and lowest tech option. Wood heating with wood stoves is standard with most homes in Nondalton for auxiliary and back-up heating. The wood stove would be easy to operate and would require minimal maintenance compared to a wood boiler system. The wood stove would be used to provide a base heat load for the building during occupied times. Occupants would fire the stove regularly to provide as much heating oil displacement as they wish. The existing Toyostove and Monitor stove would still be used to make up for additional required heating during occupied times and as heaters when the building is unoccupied. For this study, a Blaze King Classic high efficiency wood stove with an output of 48,065 BTU/hr for 12 hours was selected as the proposed biomass system to evaluate.

The second option is a wood fired boiler system, which will be more expensive and require more maintenance than a wood stove. A wood fired boiler can be loaded and fired in batches, which heats up a large volume of water for space heating. This allows a wood fired boiler to be loaded less times throughout the day then a wood stove, which would need a higher loading frequency. The wood fired boiler system would be located in a detached boiler building and heating pipes would be routed to the building. Due to the significant expense of retrofitting the building with a hydronic system and the increased complexity of a wood boiler system, this option was not evaluated in this study. Also, there appears to be limited maintenance personnel available in the community to maintain a Garn type system.

The third option is a large central plant wood boiler system that could serve multiple buildings. The central plant could serve the Community Building, Clinic Building, Ambulance Building, St. Nicholas Church and potentially the Post Office Building, Triplex Building, and Teacher Housing building. All of these buildings are within 100 yards of the Village Clinic. The buildings could be connected to a buried glycol heating loop that is connected to a central wood fired boiler plant. This option would be the most expensive, but would have the biggest ability to offset heating oil consumption. However, the clinic buildings, Post Office, and teacher housing buildings are all owned by different entities (and were outside current scope of this study), which may prove difficult to organize. A central plant system of this size and complexity would also require a maintenance staff to properly operate and maintain the system. The systems would utilize pumps, glycol, heat exchangers, boilers and a control system. Skilled maintenance personnel would be needed to operate and maintain the system.

Finally, it appears that the only available land for a central plant facility would be across the road to the north of St. Nicholas Church, which would be approximately 200 to 250 yards away from the Community Building. This option could be viable, but would require skilled maintenance personnel and buy in from all of the building owners. This option was not evaluated in this study because it is outside the scope of the current project. If the community wants to pursue this option, an additional more detailed study including all possible buildings is recommended.

V. Preliminary Site Investigation – St. Nicholas Church

Building Description

St. Nicholas Church is a 1,750 SF one story building that was built in 1987. The church is used primarily for services during the weekends and for weddings and funerals. On average, it appears that the building is occupied 10 hrs per week. There are typically 5-10 people for church services. During the holidays most of the village will attend. Due to the high cost of heating oil and the low occupancy of the building, the heat in the building is turned off during unoccupied times and the building is allowed to match ambient outside temperatures. The heat is turned on one to two days before a church service to warm the space. The building has one large room for the congregation and a smaller room behind the altar for religious materials. There have been no renovations to the building since it was originally built. Roof repairs for the church are planned to be completed when funding is available. There has been no energy audit of the building. Also located on the site is the old church, which is located immediately to the east of St. Nicholas Church. The old church appears to have no electricity or heating.

Existing Heating System

St. Nicholas Church is heated by a single Toyostove stove located in the main room. There is no boiler or boiler room. The stove is a Toyostove Laser 73, direct vented heating oil furnace with an output of 40,000 Btu/hr. The unit has its own controls and thermostat. There is no routine maintenance that is performed on the unit. The Toyostove appears to be in fair working order. The age of the unit is unknown. One 55 gal heating oil drum is located outside the building adjacent the exterior wall near the Toyostove. No spill containment is present around the tank and fuel in the tank is only used for heating.

Domestic Hot Water

There is no water service or plumbing in the building.

Building Envelope

The walls of the building are 2x6 wood stud construction that are estimated to have R-19 fiberglass batt insulation. The roof is a cold roof with a vented attic space, with an unknown amount and type of insulation because it could not be accessed. The building is on piles and floor is assumed to be insulated with R-19 fiberglass batt insulation, as soffit space was inaccessible. It is estimated that the roof insulation is R-25 fiberglass batt insulation. The windows are double pane windows. There is an unheated arctic entry for the main entrance. The building foundation is on piles and the floor of the building is not level, due to foundation settlement.

Available Space

There appears to be space inside the building for a residential style wood stove. An addition would be needed to house a larger Garn wood boiler type system.

Street Access and Fuel Storage

The building is situated on a hill with a gravel road wrapping around the uphill side of the building. There is one small gravel driveway that allows access from the road to the main entrance of the church. There is limited space around the sides and back of the structure which could make wood storage an issue. Wood storage may be able to be done on the west side of the building.

Building or Site constraints

St. Nicholas Church is on a south facing hill that slopes to the lake. The old church is located to the east of the building. Due to these factors, there is limited space for a detached boiler building to house a wood fired boiler. The west side of the building may have space, but would require brush and tree clearing and fill to level the space for construction. There is also no water service to the church, so a new water service for a boiler building would be necessary.

Biomass System Integration

The building currently has no hydronic piping, boiler, or fin-tube baseboard. Thus, to implement a wood fired boiler system, new hydronic piping and baseboards would need to be installed. A residential style high efficiency wood stove could easily be installed in the building.

Biomass System Options

The biomass options for St. Nicholas Church are identical to the options for the Community Building (see previous section for details). For this study, a Blaze King Classic high efficiency wood stove with an output of 48,065 BTU/hr for 12 hours was selected as the proposed biomass system to evaluate.

VI. Energy Consumption and Costs

Wood Energy

The gross energy content of a cord of wood varies depending on tree species and moisture content. Black spruce, white spruce and birch at 20% moisture content have respective gross energy contents of 15.9 MMBTU/Cord, 18.1 MMBTU/cord and 23.6 MMBTU/cord, according to the UAF Cooperative Extension. Wet or greenwood has higher moisture contents and require additional heat to evaporate moisture before the wood can burn. Thus, wood with higher moisture contents will have lower energy contents. Seasoned or dry wood will typically have 20% moisture content. For this study, cord wood was estimated to have 16.0 MMBTU/cord. This is a conservative estimate based on the fact that the community has access to both spruce and birch. To determine the delivered $/MMBTU of the biomass system, a 75% efficiency for the high efficiency wood stoves was assumed. This is a conservative estimate based on manufacturer documentation.

Energy Costs

The high price of fuel oil is the main economic driver for the use of lower cost biomass heating. Fuel oil is shipped into Nondalton by plane and currently costs approximately $7.66/gal. For this study, the energy content of fuel oil is based on 134,000 BTU/gal, according to the UAF Cooperative Extension.

Cord wood is sold in Nondalton not by the cord but by snow machine sled load. This is equivalent to approximately $260 per cord, which is used for this study.

The table below shows the energy comparison of different fuel types. The system efficiency is used to calculate the delivered MMBTU's of energy to the building. The delivered cost of energy to the building, in $/MMBTU, is the most accurate way to compare costs of different energy types. As shown below, cord wood is less than half the cost of fuel oil based on the $/MMBTU delivered to the building heat load.

Fuel Type	Units	Gross BTU/unit	System Efficiency	$/unit	Delivered $/MMBTU
Cord Wood	Cords	16,000,000	75%	$260	$21.67
Fuel Oil	Gal	134,000	80%	$7.66	$71.46
Electricity	kWh	3,413	99%	$0.56	$165.74

Table 2 – Energy Comparison

Existing Fuel Oil Consumption

Complete heating oil bills were not provided for the three Nondalton buildings. The heating oil consumption for each building was estimated based on interviews with Mr. William Evanoff, the current Tribal Council President. According to Mr. Evanoff, the community building consumes three 55 gallon drums of heating oil each month during the winter from October to April. During the summer from May to September the community building uses approximately one 55 gal drum per month. Based on these estimates, the community building consumes approximately 1,450 gallons per year.

The heating oil consumption of the Tribal Office Building is similar to the community building and is estimated at 1,590 gallons per year, based on the additional square footage. The consumption of the St. Nicholas Church is estimated at 365 gallons of heating oil per year, due to the fact that the church is only heated 2 days per week.

Building Name	Fuel Type	Avg. Annual Consumption	Net MMBTU/yr	Annual Fuel Cost
Tribal Office Building	Fuel Oil	1,590 gal	170.4	$12,179
Community Building	Fuel Oil	1,450 gal	155.4	$11,107
St. Nicholas Church	Fuel Oil	365 gal	39.1	$2,796

Table 3 – Existing Fuel Oil Consumption

Biomass System Consumption

The proposed biomass system for each building is a high efficiency wood stove. While wood stoves are capable of providing the majority of the space heat for each building, a conservative estimate of 50% heating oil offset was used for the study. Due to the fact that the buildings are not occupied constantly and that the wood stoves are hand fired, a 50% heating oil offset is a realistic estimate for this study. If the building tenants wish to offset more heating oil, the wood stove can be fired on a more frequent schedule.

Building Name	Fuel Type	% Heating Source	Net MMBTU/yr	Annual Consumption	Energy Cost	Total Energy Cost
Tribal Office Building	Cord Wood	50%	85.2	7.1 cords	$1,847	$7,936
	Fuel Oil	50%	85.2	795 gal	$6,090	
Community Building	Cord Wood	50%	77.7	6.5 cords	$1,684	$7,237
	Fuel Oil	50%	77.7	725 gal	$5,554	

Building Name	Fuel Type	% Heating Source	Net MMBTU/yr	Annual Consumption	Energy Cost	Total Energy Cost
St. Nicholas Church	Cord Wood	50%	19.6	1.6 cords	$424	$1,822
	Fuel Oil	50%	19.6	183 gal	$1,398	

Table 4 – Proposed Biomass System Fuel Consumption

VII. Preliminary Cost Estimating

An estimate of probable costs was completed for the installation of a high efficiency wood stove for each building. The basis of design is a Blaze King Classic high efficiency wood stove with an output of 48,065 BTU/hr for 12 hours. This cost estimate is used for each of the three study buildings in Nondalton: Tribal Office, Community Building and St. Nicholas Church. The cost estimate is for one building.

The estimate includes general conditions and overhead and profit for the general contractor. A 10% remote factor was used to account for increased shipping and installation costs in Nondalton. Engineering design and permitting was estimated at 15% and a 10% contingency was used.

Estimate of Probable Costs for High Efficiency Wood Stove in Nondalton					
Category	**Description**	**Unit**	**Unit Cost**	**Quantity**	**Cost**
High Efficiency Wood Stove	Wood Stove	Each	$2,500.00	1	$2,500
	Blower Fan	Each	$ 500.00	1	$500
	Stack	Each	$ 500.00	1	$500
				Subtotal	**$3,500**
Installation	Area Prep	hrs	$ 150.00	8	$1,200
	Stove and Chimney Install	hrs	$ 150.00	8	$1,200
	Additional Parts Allowance	Each	$1,000.00	1	$1,000
				Subtotal	**$3,400**
Shipping	600 lbs Shipping	Job	$1,000.00	1	$1,000
				Subtotal	**$1,000**
Subtotal Material and Installation Cost					**$7,900**
General Conditions	5%				$395
				Subtotal	**$8,295**
Overhead and Profit	5%				$415
				Subtotal	**$8,710**
Remote Factor	10%				$871
				Subtotal	**$9,581**
Design Fees and Permitting	15%				$1,437
				Subtotal	**$11,018**
Contingency	10%				$1,102
Total Project Cost					**$12,120**

Table 5 – Estimate of Probable Costs for High Efficiency Wood Stove in Nondalton

VIII. Economic Analysis

The following assumptions were used to complete the economic analysis for the proposed biomass systems in Nondalton.

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Table 6 – Inflation rates

The real discount rate, or minimum attractive rate of return, is 3.0% and is the current rate used for all Life Cycle Cost Analysis by the Alaska Department of Education and Early Development. This is a typical rate used for completing economic analysis for public entities in Alaska. The escalation rates used for the wood, heating oil, electricity and O&M rates are based on rates used in the Alaska Energy Authority funded 2012 biomass pre-feasibility studies. These are typical rates used for this level of evaluation and were used so that results are consistent and comparable to the 2012 studies.

O&M Costs

Non-fuel related operations and maintenance costs (O&M) were estimated at $50 per year. For the first two years of service, an additional $50 per year was added to account for maintenance staff getting used to operating the new system. The maintenance of the high efficiency wood stove is relatively low due to the system's simple construction and few moving parts. Wood stoves are also common in the community and community members have knowledge of how to operate them.

Definitions

There are many different economic terms used in this study. A listing of all of the terms with their definition is provided below for reference.

Economic Term	**Description**
Project Capital Cost	This is the opinion of probable cost for designing and constructing the project.
Simple Payback	The Simple Payback is the Project Capital Cost divided by the first year annual energy savings. The Simple Payback does not take into account escalated energy prices. $$Simple\ Payback = \frac{Installed\ Cost\ of\ ECM}{First\ Year\ Energy\ Savings\ of\ ECM}$$
Present Value of Project Benefits (20 year life)	The present value of all of the heating oil that would have been consumed by the existing heating oil-fired heating system, over a 20 year period.

Economic Term	Description
Present Value of Operating Costs (20 year life)	The present value of all of the proposed biomass systems operating costs over a 20 year period. This includes wood fuel, additional electricity, and O&M costs for the proposed biomass system to provide 85% of the building's heat. It also includes the heating oil required for the existing oil-fired boilers to provide the remaining 15% of heat to the building.
Benefit / Cost Ratio of Project (20 year life)	This is the benefit to cost ratio over the 20 year period. A project that has a benefit to cost ratio greater 1.0 is economically justified. It is defined as follows: $$Benefit\ /\ Cost\ Ratio = \frac{PV(Project\ Benefits) - PV(Operating\ Costs)}{Project\ Capital\ Cost}$$ Where: PV = The present value over the 20 year period. Reference Sullivan, Wicks and Koelling, "Engineering Economy", 14th ed., 2009, pg. 440, Modified B-C Ratio.
Net Present Value (20 year life)	This is the net present value of the project over a 20 year period. If the project has a net present value greater than zero, the project is economically justified. This quantity accounts for the project capital cost, project benefits and operating costs.
Year Accumulated Cash Flow > Project Capital Cost	This is the number of years it takes for the accumulated cash flow of the project to be greater than or equal to the project capital cost. This is similar to the project's simple payback, except that it incorporates the inflation rates. This quantity is the payback of the project including escalating energy prices and O&M rates. This quantity is calculated as follows: $$Installed\ Cost \leq \sum_{k=0}^{J} R_k$$ Where: J = Year that the accumulated cash flow is greater than or equal to the Project Capital Cost. R_k = Project Cash flow for the kth year.

Table 7 – Economic Definitions

Results

The economic analysis was completed in order to determine the simple payback, benefit to cost ratio, and net present value of the proposed biomass system at each building. The results of the proposed high efficiency wood stoves are shown in the table below.

Based on the economic analysis it was determined that all of the proposed biomass systems at the three buildings in Nondalton have benefit to cost ratios above 1.0, and are economically justified. The driving factors that make these projects cost effective are their relatively low project capital cost, combined with the high price of heating oil. A high efficiency wood stove is much cheaper than utilizing an expensive and complex high efficiency wood boiler and all the necessary hydronic piping required to integrate into the buildings.

Economic Analysis Results			
Building	**Tribal Office Building**	**Community Building**	**St. Nicholas Church**
Project Capital Cost	($12,120)	($12,120)	($12,120)
Simple Payback	2.9 years	3.2 years	13.8 years
Present Value of Project Benefits (20 year life)	$285,647	$260,496	$65,573
Present Value of Operating Costs (20 year life)	($179,651)	($164,047)	($41,937)
Benefit / Cost Ratio of Project (20 year life)	8.75	7.96	1.95
Net Present Value (20 year life)	$93,876	$84,330	$11,516
Year Accumulated Cash Flow is Net Positive	First Year	First Year	First Year
Year Accumulated Cash Flow > Project Capital Cost	2.8 years	3.0 years	10.0 years

Table 8 – Economic Analysis Results

Sensitivity Analysis

A sensitivity analysis for the three Nondalton buildings was not completed because all projects are economically justified, with high benefit to cost ratios. Even if the price of heating oil drops to $2.70 per gallon, the Tribal Office Building and Community Building projects will still have a benefit to cost ratio of 1.0. The St. Nicholas Church will still have a benefit to cost ratio of 1.0 if heating oil drops to $4.96 per gallon.

IX. Forest Resource and Fuel Availability Assessments

Forest Resource Assessments

Fuel availability assessments were not available for the Nondalton area. During the site visit it was found that the land around Nondalton village is densely forested, with a high density of spruce and some birch trees. Due to the limited length of roads, wood harvesting is typically accomplished in the winter with snow machines pulling sleds.

Per Coffman's discussions with Mr. Will Putman with the State Forestry Service, most of the permits for wood harvesting are owned and controlled by village corporations within the state. If harvesting is to take place in these areas, permission will need to be obtained from the village corporation prior to harvesting. If more than 40 acres per year or 50 cords of wood are collected per year, the harvesting is classified as a commercial operation. For a commercial harvest, the practices outlined in the Forest Resources and Practices Act will need to be followed. The Forest Resource and Practices Act protects the water and habitat within the harvesting site and applies to state, federal, and native corporation land. If less than 40 cords of wood are used per year, the use is considered as a personal use and a commercial permit is not required.

Air Quality Permitting

Currently, air quality permitting is regulated according to the Alaska Department of Environmental Conservation Section 18 AAC 50 Air Quality Control regulations. Per these regulations, a minor air quality permit is required if a new wood boiler or wood stove produces one of the following conditions per Section 18 AAC 50.502 (C)(1): 40 tons per year (TPY) of carbon dioxide (CO2), 15 TPY of particulate matter greater than 10 microns (PM-10), 40 TPY of sulfur dioxide, 0.6 TPY of lead, 100 TPY of carbon monoxide within 10 kilometers of a carbon monoxide nonattainment area, or 10 TPY of direct PM-2.5 emissions. These regulations assume that the device will operate 24 hours per day, 365 days per year and that no fuel burning equipment is used. If a new wood boiler or wood stove is installed in addition to a fuel burning heating device, the increase in air pollutants cannot exceed the following per AAC 50.502 (C)(3): 10 TPY of PM-10, 10 TPY of sulfur dioxide, 10 TPY of nitrogen oxides, 100 TPY of carbon monoxide within 10 kilometers of a carbon monoxide nonattainment area, or 10 TPY of direct PM-2.5 emissions. Per the Wood-fired Heating Device Visible Emission Standards (Section 18 AAC 50.075), a person may not operate a wood-fired heating device in a manner that causes black smoke or visible emissions that exceed 50 percent opacity for more than 15 minutes in any hour in an area where an air quality advisory is in effect.

From Coffman's discussions with Patrick Dunn at the Alaska Department of Environmental Conservation, these regulations are focused on permitting industrial applications of wood burning equipment. In his opinion, it would be unlikely that an individual wood boiler would require an air quality permit unless several boilers were to be installed and operated at the same site. If several boilers were installed and operated together, the emissions produced could be greater than 40 tons of CO2 per year. This would require permitting per AAC 50.502 (C)(1) or (C)(3). Permitting would not be required on the residential wood fired stoves unless they violated the Wood-fired Heating Device Visible Emission Standards (Section 18 AAC 50.075). Similar systems installed in Alaska have not required or obtained air quality permits.

X. General Biomass Technology Information

Heating with Wood Fuel

Wood fuels are among the most cost-effective and reliable sources of heating fuel for communities adjacent to forestland when the wood fuels are processed, handled, and combusted appropriately. Compared to other heating energy fuels, such as oil and propane, wood fuels typically have lower energy density and higher associated transportation and handling costs. Due to this low bulk density, wood fuels have a shorter viable haul distance when compared to fossil fuels. This short haul distance also creates an advantage for local communities to utilize locally-sourced wood fuels, while simultaneously retaining local energy dollars.

Most villages in rural Alaska are particularly vulnerable to high energy prices due to the large number of heating degree days and expensive shipping costs. For many communities, wood-fueled heating can lower fuel costs. For example, cordwood sourced at $250 per cord is just 25% of the cost per MMBTU as #1 fuel oil sourced at $7 per gallon. In addition to the financial savings, the local communities also benefit from the multiplier effect of circulating energy dollars within the community longer, more stable energy prices, job creation, and more active forest management.

In all of the Lake and Peninsula Communities studied, the community's wood supply and demand are isolated from outside markets. The local cordwood market is influenced by land ownership, existing forest management and ecological conditions, local demand and supply, and the State of Alaska Energy Assistance program.

Types of Wood Fuel

Wood fuels are specified by energy density, moisture content, ash content, and granulometry. Each of these characteristics affects the wood fuel's handling characteristics, storage requirements, and combustion process. Higher quality fuels have lower moisture, ash, dirt, and rock contents, consistent granulometry, and higher energy density. Different types of fuel quality can be used in wood heating projects as long as the infrastructure specifications match the fuel content characteristics. Typically, lower quality fuel will be the lowest cost fuel, but it will require more expensive storage, handling, and combustion infrastructure, as well as additional maintenance.

Projects in rural Alaska must be designed around the availability of wood fuels. Some fuels can be harvested and manufactured on site, such as cordwood, woodchips, and briquettes. The economic feasibility of manufacturing on site is determined by a financial assessment of the project. Typically, larger projects offer more flexibility in terms of owning and operating the wood harvesting and manufacturing equipment, such as a wood chipper, splitter, or equipment to haul wood out of forest, than smaller projects.

Due to the limited wood fuel demand, large financial obligations and operating complexities, it is unlikely that the Lake and Peninsula communities in this study will be able to manufacture pellets. However, some communities may be able to manufacture bricks or fire logs made from pressed wood material. These products can substitute for cordwood in woodstoves and boilers, while reducing supply pressure on larger diameter trees that are generally preferred for cordwood.

High Efficiency Cord Wood Boilers

High Efficiency Low Emission (HELE) cordwood boilers are designed to burn cordwood fuel cleanly and efficiently. The boilers use cordwood that is typically seasoned to 25% moisture content (MC) or less and meet the dimensions required for loading and firing. The amount of cordwood burned by the boiler will depend on the heat load profile of the building and the utilization of the fuel oil system as back up. Three HELE cordwood boiler suppliers include Garn (www.garn.com), Greenwood (www.greenwoodusa.com) and TarmUSA (www.woodboilers.com). All three of these suppliers have units operating in Alaska. Greenwood and TarmUSA have a number of residential units operating in Alaska and have models that range between 100,000 to 300,000 BTU/hr. Garn boilers, manufactured by Dectra Corporation, are used in Tanana, Kasilof, Dot Lake, Thorne Bay, Coffman Cove and other locations to heat homes, washaterias, schools, and community buildings.

The Garn boiler has a unique construction, which is basically a wood boiler housed in a large water tank. Garn boilers come in several sizes and are appropriate for facilities using 100,000 to 1,000,000 BTUs per hour. The jacket of water surrounding the fire box absorbs heat and is piped into buildings via a heat exchanger, and then transferred to an existing building heating system, infloor radiant tubing, unit heaters, or baseboard heaters. In installations where the Garn boiler is in a detached building, there are additional heat exchangers, pumps and a glycol circulation loop that are necessary to transfer heat to the building while allowing for freeze protection. Radiant floor heating is the most efficient heating method when using wood boilers such as Garns, because they can operate using lower supply water temperatures compared to baseboards.

Garn boilers are approximately 87% efficient and store a large quantity of water. For example, the Garn WHS-2000 holds approximately 1,825 gallons of heated water. Garns also produce virtually no smoke when at full burn, because of a primary and secondary gasification (2,000 ^{o}F) burning process. Garns are manually stocked with cordwood and can be loaded multiple times a day during periods of high heating demand. Garns are simple to operate with only three moving parts: a handle, door and blower. Garns produce very little ash and require minimal maintenance. Removing ash and inspecting fans are typical maintenance requirements. Fans are used to produce a draft that increases combustion temperatures and boiler efficiency. In cold climates, Garns can be equipped with exterior insulated storage tanks for extra hot water circulating capacity. Most facilities using cordwood boilers keep existing oil-fired systems operational to provide heating backup during biomass boiler downtimes and to provide additional heat for peak heating demand periods.

Low Efficiency Cord Wood Boilers

Outdoor boilers are categorized as low-efficiency, high emission (LEHE) systems. These boiler systems are not recommended as they produce significant emission issues and do not combust wood fuels efficiently or completely, resulting in significant energy waste and pollution. These systems require significantly more wood to be purchased, handled and combusted to heat a facility as compared to a HELE system. The Alaska Department of Environmental Conservation has issued nuisance abatement orders for air pollution for outdoor wood boilers in Fairbanks. Fairbanks is ranked number four on Time Magazine's list of most air polluted cities in America. Additionally, several states have placed a moratorium on installing LEHE boilers because of air quality issues (Washington). These LEHE systems can have combustion efficiencies as low as twenty five (25%) percent and produce more than nine times the emission rate of standard industrial boilers. In comparison, Garns can operate around 87% efficiency.

High Efficiency Wood Stoves

Newer high efficiency wood stoves are available on the market that produce minimal smoke, minimal ash and require less firewood. New EPA-certified wood stoves produce significantly less smoke than older uncertified wood stoves. High efficiency wood stoves are easy to operate with minimal maintenance compared to other biomass systems. The Blaze King Classic high efficiency wood stove (www.blazeking.com) is a recommended model, due to its built-in thermostats that monitor the heat output of the stove. This stove automatically adjusts the air required for combustion. This unique technology, combined with the efficiencies of a catalytic combustor with a built-in thermostat, provides the longest burn times of any wood stove. The Blaze King stove allows for optimal combustion and less frequent loading and firing times.

Bulk Fuel Boilers

Bulk fuel boilers usually burn wood chips, sawdust, bark or pellets and are designed around the wood resources that are available from the local forests or local industry. Several large facilities in Tok, Craig, and Delta Junction (Delta Greely High School) are using bulk fuel biomass systems. Tok uses a commercial grinder to process woodchips. The chips are then dumped into a bin and are carried by a conveyor belt to the boiler. The wood fuel comes from timber scraps, local sawmills and forest thinning projects. The Delta Greely High School has a woodchip bulk fuel boiler that heats the 77,000 square foot facility. The Delta Greely system, designed by Coffman engineers, includes a completely separate boiler building which includes chip storage bunker and space for storage of tractor trailers full of chips (so handling of frozen chips could be avoided). Woodchips are stored in the concrete bunker and augers move the material on a conveyor belt to the boilers. The automated fuel handling requirements for bulk fuel systems are not cost-effective for small and medium sized structures due to higher maintenance costs and complexities. Due to these reasons, a bulk fuel boiler system is not recommended for small rural communities in Alaska with limited financial and human resources.

Grants

There are many grant opportunities for biomass work state, federal, and local for feasibility studies, design and construction. If a project if determined to be pursued, a thorough search of websites and discussions with the AEA Biomass group would be recommended to make sure no possible funding opportunities are missed. Below are some funding opportunities and existing past grants that have been awarded.

Currently, there is a funding opportunity for tribal communities that develop clean and renewable energy resources through the U.S. Department of Energy. On April 30, 2013, the Department of Energy announced up to $7 million was available to deploy clean energy projects in tribal communities to reduce reliance on fossil fuel and promote economic development on tribal lands. The Energy Department's Tribal Energy Program, in cooperation with the Office of Indian Energy, will help Native American communities, tribal energy resource development organizations, and tribal consortia to install community or facility scale clean energy projects.

http://apps1.eere.energy.gov/tribalenergy/

The Department of Energy (DOE), Alaska Native programs, focus on energy efficiency and add ocean energy into the mix. In addition the communities are eligible for up to $250,000 in energy-efficiency aid. The Native village of Kongiganak will get help strengthening its wind-energy infrastructure, increasing energy efficiency and developing "smart grid technology". Koyukuk will get help upgrading its energy infrastructure, improving energy efficiency and exploring biomass options. The village of Minto will explore all the above options as well as look for solar-energy ideas. Shishmaref, an Alaska Native village faced climate-change-induced relocation, will receive help with increasing energy sustainability and building capacity as it relocates. And the Yakutat T'lingit Tribe will also study efficiency, biomass and ocean energy. This DOE program would be a viable avenue for biomass funding.

http://energy.gov/articles/alaska-native-communities-receive-technical-assistance-local-clean-energy-development

The city of Nulato was awarded a $40,420 grant for engineering services for a wood energy project by the United States Department of Agriculture (USDA) and the United States Forest Service. Links regarding the award of the Woody Biomass Utilization Project recipients are shown below:

http://www.fs.fed.us/news/2012/releases/07/renewablewoods.shtml

http://www.usda.gov/wps/portal/usda/usdahome?contentid=2009/08/0403.xml

Delta Junction was awarded a grant for engineering from the Alaska Energy Authority from the Renewable Energy Fund for $831,203. This fund provides assistance to utilities, independent power producers, local governments, and tribal governments for feasibility studies, reconnaissance studies, energy resource monitoring, and work related to the design and construction of eligible facilities.

http://www.akenergyauthority.org/re-fund-6/4_Program_Update/FinalREFStatusAppendix2013.pdf

http://www.akenergyauthority.org/PDF%20files/PFS-BiomassProgramFactSheet.pdf

http://www.akenergyauthority.org/RenewableEnergyFund/RFA_Project_Locations_20Oct08.pdf

The Alaska Wood Energy Development Task Group (AWEDTG) consists of a coalition of federal and state agencies and not-for-profit organizations that have signed a Memorandum of Understanding (MOU) to explore opportunities to increase the utilization of wood for energy and biofuels production in Alaska. A pre-feasibility study for Aleknagik was conducted in 2012 for the AWEDTG. The preliminary costs for the biomass system(s) are $346,257 for the city hall and health center system and $439,096 for the city hall, health center, and future washeteria system.

http://www.akenergyauthority.org/biomasswoodenergygrants.html

http://www.akenergyauthority.org/BiomassWoodEnergy/Aleknagik%20Final%20Report.pdf

The Emerging Energy Technology Fund grand program provides funds to eligible applicants for demonstrations projects of technologies that have a reasonable expectation to be commercially viable within five years and that are designed to: test emerging energy technologies or methods of conserving energy, improve an existing energy technology, or deploy an existing technology that has not previously been demonstrated in Alaska.

http://www.akenergyauthority.org/EETFundGrantProgram.html

Appendix A
Site Photos

1. Tribal Office Building - South elevation

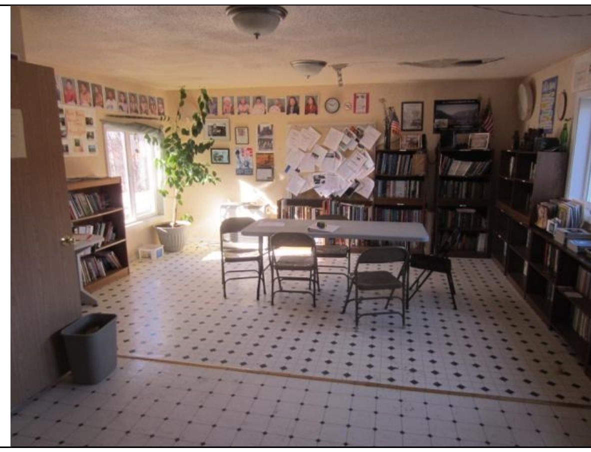
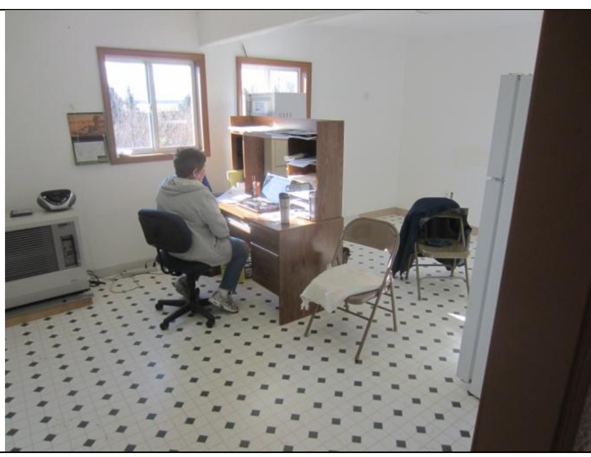
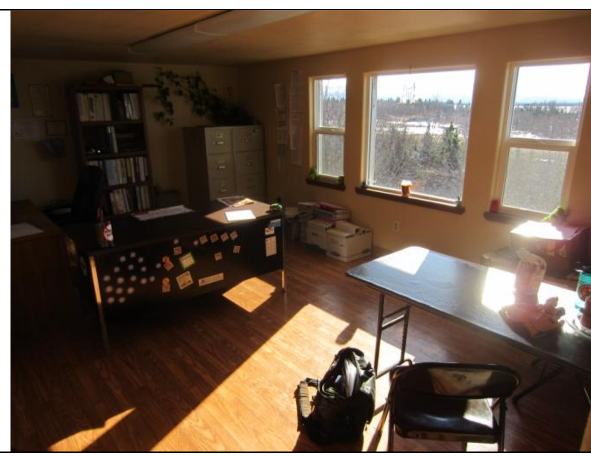
2. Tribal Office Building - West elevation

3. Tribal Office Building - North elevation

4. Tribal Office Building - East elevation

5. Tribal Office Building – Site Entrance

6. Tribal Office Building – West fuel tank

	
7. Tribal Office Building – East fuel tank	8. Tribal Office Building – Monitor Stove
	
9. Tribal Office Building - Toyostove	10. Tribal Office Building – Conference Room
	
11. Tribal Office Building – First Floor Office Space	12. Tribal Office Building – Second Floor Office Space


13. Community Building - South elevation


14. Community Building - West elevation

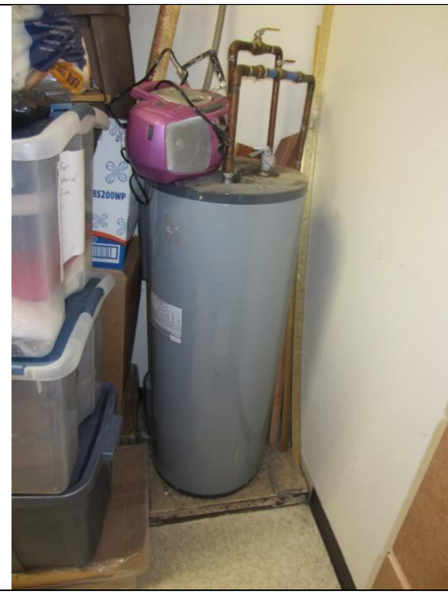

15. Community Building - North elevation


16. Community Building - East elevation


17. Community Building – Site Entrance


18. Community Building – West fuel tank

19. Community Building – Monitor Stove



20. Community Building – Electric Water Heater

21. Community Building - Kitchen

22. Community Building – Main Room

23. Community Building – Main Room

24. Community Building – adjacent communications conex and satellite dish

25. St. Nicholas Church - South elevation

26. St. Nicholas Church - West elevation

27. St. Nicholas Church - North elevation

28. St. Nicholas Church - East elevation

29. St. Nicholas Church – Site Entrance

30. St. Nicholas Church – West fuel tank

31. St. Nicholas Church – Toyostove

32. St. Nicholas Church – Main Room

33. St. Nicholas Church – North Road

34. St. Nicholas Church – East Road

Appendix B
Economic Analysis Spreadsheet

Nondalton Community Building
Nondalton, Alaska

Economic Analysis Results	
Project Capital Cost	($12,120)
Simple Payback = Total Project Cost / First Year Cost Savings	3.2 years
Present Value of Project Benefits (20 year life)	$260,496
Present Value of Operating Costs (20 year life)	($164,047)
Benefit / Cost Ratio of Project (20 year life)	7.96
Net Present Value (20 year life)	$84,330
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	3.0 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Description	Unit Cost	Heating Source Proportion	Annual Energy Units	Energy Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Existing Heating System Operating Costs																								
Existing Heating Oil Consumption	$7.66		1,450	gal	**$11,107**	**$11,662**	**$12,245**	**$12,858**	**$13,501**	**$14,176**	**$14,884**	**$15,629**	**$16,410**	**$17,231**	**$18,092**	**$18,997**	**$19,947**	**$20,944**	**$21,991**	**$23,091**	**$24,245**	**$25,457**	**$26,730**	**$28,067**
Biomass System Operating Costs																								
Wood Fuel (Delivered to site)	$260.00	50%	6.5	cord	($1,690)	($1,741)	($1,793)	($1,847)	($1,902)	($1,959)	($2,018)	($2,078)	($2,141)	($2,205)	($2,271)	($2,339)	($2,410)	($2,482)	($2,556)	($2,633)	($2,712)	($2,793)	($2,877)	($2,963)
Fossil Fuel	$7.66	50%	725	gal	($5,554)	($5,831)	($6,123)	($6,429)	($6,750)	($7,088)	($7,442)	($7,814)	($8,205)	($8,615)	($9,046)	($9,498)	($9,973)	($10,472)	($10,996)	($11,545)	($12,123)	($12,729)	($13,365)	($14,033)
Electricity	$0.56		0	kWh	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operation and Maintenance Costs					($50)	($51)	($52)	($53)	($54)	($55)	($56)	($57)	($59)	($60)	($61)	($62)	($63)	($65)	($66)	($67)	($69)	($70)	($71)	($73)
Additional Operation and Maintenance Costs for first 2 years					($50)	($51)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($7,344)**	**($7,674)**	**($7,968)**	**($8,329)**	**($8,707)**	**($9,102)**	**($9,516)**	**($9,950)**	**($10,404)**	**($10,880)**	**($11,378)**	**($11,900)**	**($12,446)**	**($13,018)**	**($13,618)**	**($14,246)**	**($14,903)**	**($15,592)**	**($16,314)**	**($17,070)**
Annual Operating Cost Savings					$3,764	$3,988	$4,278	$4,529	$4,794	$5,073	$5,368	$5,678	$6,006	$6,350	$6,714	$7,097	$7,500	$7,925	$8,373	$8,845	$9,342	$9,865	$10,417	$10,997
Accumulated Cash Flow					$3,764	$7,752	$12,030	$16,559	$21,353	$26,426	$31,794	$37,473	$43,478	$49,829	$56,543	$63,640	$71,140	$79,065	$87,439	$96,284	$105,626	$115,491	$125,908	$136,905
Net Present Value					**($8,466)**	**($4,707)**	**($792)**	**$3,232**	**$7,368**	**$11,617**	**$15,981**	**$20,464**	**$25,067**	**$29,792**	**$34,642**	**$39,620**	**$44,727**	**$49,967**	**$55,341**	**$60,853**	**$66,505**	**$72,300**	**$78,241**	**$84,330**

Nondalton St. Nicholas Church
Nondalton, Alaska

Economic Analysis Results	
Project Capital Cost	($12,120)
Simple Payback = Total Project Cost / First Year Cost Savings	13.8 years
Present Value of Project Benefits (20 year life)	$65,573
Present Value of Operating Costs (20 year life)	($41,937)
Benefit / Cost Ratio of Project (20 year life)	1.95
Net Present Value (20 year life)	$11,516
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	10.0 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Description	Unit Cost	Heating Source Proportion	Annual Energy Units	Energy Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Existing Heating System Operating Costs														
Existing Heating Oil Consumption	$7.66		365	gal	**$2,796**	**$2,936**	**$3,082**	**$3,237**	**$3,398**	**$3,568**	**$3,747**	**$3,934**	**$4,131**	**$4,337**
Biomass System Operating Costs														
Wood Fuel (Delivered to site)	$260.00	50%	1.6	cord	($416)	($428)	($441)	($455)	($468)	($482)	($497)	($512)	($527)	($543)
Fossil Fuel	$7.66	50%	183	gal	($1,402)	($1,472)	($1,545)	($1,623)	($1,704)	($1,789)	($1,879)	($1,972)	($2,071)	($2,175)
Electricity	$0.56		0	kWh	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operation and Maintenance Costs					($50)	($51)	($52)	($53)	($54)	($55)	($56)	($57)	($59)	($60)
Additional Operation and Maintenance Costs for first 2 years					($50)	($51)	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($1,918)**	**($2,002)**	**($2,039)**	**($2,130)**	**($2,226)**	**($2,327)**	**($2,432)**	**($2,542)**	**($2,657)**	**($2,777)**
Annual Operating Cost Savings					$878	$933	$1,044	$1,106	$1,172	$1,242	$1,315	$1,393	$1,474	$1,560
Accumulated Cash Flow					$878	$1,811	$2,855	$3,961	$5,134	$6,375	$7,691	$9,083	$10,557	$12,118
Net Present Value					**($11,267)**	**($10,388)**	**($9,433)**	**($8,450)**	**($7,439)**	**($6,399)**	**($5,329)**	**($4,230)**	**($3,100)**	**($1,939)**

Description	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Existing Heating System Operating Costs										
Existing Heating Oil Consumption	**$4,554**	**$4,782**	**$5,021**	**$5,272**	**$5,536**	**$5,812**	**$6,103**	**$6,408**	**$6,729**	**$7,065**
Biomass System Operating Costs										
Wood Fuel (Delivered to site)	($559)	($576)	($593)	($611)	($629)	($648)	($668)	($688)	($708)	($729)
Fossil Fuel	($2,283)	($2,398)	($2,517)	($2,643)	($2,775)	($2,914)	($3,060)	($3,213)	($3,374)	($3,542)
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operation and Maintenance Costs	($61)	($62)	($63)	($65)	($66)	($67)	($69)	($70)	($71)	($73)
Additional Operation and Maintenance Costs for first 2 years	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs	**($2,903)**	**($3,036)**	**($3,174)**	**($3,319)**	**($3,471)**	**($3,630)**	**($3,796)**	**($3,971)**	**($4,153)**	**($4,345)**
Annual Operating Cost Savings	$1,651	$1,746	$1,847	$1,953	$2,065	$2,183	$2,307	$2,438	$2,575	$2,721
Accumulated Cash Flow	$13,768	$15,515	$17,362	$19,315	$21,380	$23,563	$25,870	$28,308	$30,883	$33,604
Net Present Value	**($746)**	**$478**	**$1,736**	**$3,028**	**$4,353**	**$5,713**	**$7,109**	**$8,541**	**$10,010**	**$11,516**

Nondalton Tribal Office Building
Nondalton, Alaska

Economic Analysis Results	
Project Capital Cost	($12,120)
Simple Payback = Total Project Cost / First Year Cost Savings	2.9 years
Present Value of Project Benefits (20 year life)	$285,647
Present Value of Operating Costs (20 year life)	($179,651)
Benefit / Cost Ratio of Project (20 year life)	8.75
Net Present Value (20 year life)	$93,876
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	2.8 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Description	Unit Cost	Heating Source Proportion	Annual Energy Units	Energy Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Existing Heating System Operating Costs														
Existing Heating Oil Consumption	$7.66		1,590	gal	**$12,179**	**$12,788**	**$13,428**	**$14,099**	**$14,804**	**$15,544**	**$16,322**	**$17,138**	**$17,995**	**$18,894**
Biomass System Operating Costs														
Wood Fuel (Delivered to site)	$260.00	50%	7.1	cord	($1,846)	($1,901)	($1,958)	($2,017)	($2,078)	($2,140)	($2,204)	($2,270)	($2,338)	($2,409)
Fossil Fuel	$7.66	50%	795	gal	($6,090)	($6,394)	($6,714)	($7,050)	($7,402)	($7,772)	($8,161)	($8,569)	($8,997)	($9,447)
Electricity	$0.56		0	kWh	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operation and Maintenance Costs					($50)	($51)	($52)	($53)	($54)	($55)	($56)	($57)	($59)	($60)
Additional Operation and Maintenance Costs for first 2 years					($50)	($51)	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($8,036)**	**($8,398)**	**($8,724)**	**($9,120)**	**($9,534)**	**($9,967)**	**($10,421)**	**($10,897)**	**($11,394)**	**($11,915)**
Annual Operating Cost Savings					$4,144	$4,391	$4,703	$4,979	$5,270	$5,577	$5,900	$6,241	$6,600	$6,979
Accumulated Cash Flow					$4,144	$8,535	$13,238	$18,217	$23,488	$29,065	$34,965	$41,206	$47,806	$54,785
Net Present Value					**($8,097)**	**($3,958)**	**$346**	**$4,770**	**$9,316**	**$13,987**	**$18,784**	**$23,711**	**$28,770**	**$33,963**

Description	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Existing Heating System Operating Costs										
Existing Heating Oil Consumption	**$19,839**	**$20,831**	**$21,872**	**$22,966**	**$24,114**	**$25,320**	**$26,586**	**$27,915**	**$29,311**	**$30,777**
Biomass System Operating Costs										
Wood Fuel (Delivered to site)	($2,481)	($2,555)	($2,632)	($2,711)	($2,792)	($2,876)	($2,962)	($3,051)	($3,143)	($3,237)
Fossil Fuel	($9,919)	($10,415)	($10,936)	($11,483)	($12,057)	($12,660)	($13,293)	($13,958)	($14,656)	($15,388)
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operation and Maintenance Costs	($61)	($62)	($63)	($65)	($66)	($67)	($69)	($70)	($71)	($73)
Additional Operation and Maintenance Costs for first 2 years	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs	**($12,461)**	**($13,033)**	**($13,632)**	**($14,259)**	**($14,915)**	**($15,603)**	**($16,324)**	**($17,079)**	**($17,870)**	**($18,698)**
Annual Operating Cost Savings	$7,378	$7,798	$8,241	$8,707	$9,199	$9,717	$10,262	$10,837	$11,441	$12,079
Accumulated Cash Flow	$62,162	$69,960	$78,201	$86,909	$96,108	$105,824	$116,087	$126,923	$138,365	$150,443
Net Present Value	**$39,292**	**$44,762**	**$50,373**	**$56,130**	**$62,034**	**$68,090**	**$74,298**	**$80,664**	**$87,189**	**$93,876**

Appendix C
Site Plan

Site Plan of Nondalton Village Center

Site Plan of Nondalton Village Center

Appendix D
AWEDTG Field Data Sheet

ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)

PRE-FEASIBILITY ASSESSMENT **FIELD DATA SHEET**

APPLICANT:	Nondalton Tribal Council		
Eligibility: (check one)	[X] Local government ☐ State agency ☐ Federal agency ☐ School/School District ☐ Federally Recognized Tribe ☐ Regional ANCSA Corp. ☐ Village ANCSA Corp. ☐ Not-for-profit organization ☐ Private Entity that can demonstrate a Public Benefit ☐ Other (describe):		
Contact Name:	William Evanoff		
Mailing Address:	P.O. Box 49		
City:	Nondalton		
State:	AK	**Zip Code:**	99640
Office phone:	(907) 294-2257	**Cell phone:**	( )
Fax:	(907) 294-2271		
Email:	ntcnahasda@yahoo.com		

Facility Identification/Name:	St. Nicholas Church	
Facility Contact Person:	William Evanoff	
Facility Contact Telephone:	(907) 294-2257	( )
Facility Contact Email:	ntcnahasda@yahoo.com	

SCHOOL/FACILITY INFORMATION (complete separate Field Data Sheet for each building)

SCHOOL FACILITY (Name: ____________________)

School Type: (check all that apply)	[ ] Pre-School [ ] Elementary [ ] Middle School	[ ] Junior High [ ] High School [ ] Campus	[ ] Student Housing [ ] Pool [ ] Gymnasium	[ ] Other (describe):
Size of facility (sq. ft. heated):		Year built/age:		
Number of floors:		Year(s) renovated:		
Number of bldgs.:		Next renovation:		
# of Students:		Has en energy audit been conducted?:		If Yes, when? *

OTHER FACILITY (Name: St. Nicholas Church)

Type:	[ ] Health Clinic [ ] Public Safety Bldg. [ ] Community Center	[ ] Water Plant [ ] Washeteria [ ] Public Housing	[ ] Multi-Purpose Bldg [ ] District Energy System [X] Other (list): Church
Size of Facility (sq. ft. heated)	1,750 SF.	Year built/age:	1987 / 26 yrs
Number of floors:	1	Year(s) renovated:	NONE
Number of bldgs.:	1	Next renovation:	Scheduled roof repairs.
Frequency of Usage:	Saturday/Sunday.	# of Occupants	10 for church services, whole village for holiday.
Has an energy audit been conducted?	No	~~If Yes, when? *~~	

→ Some use on weekdays. Mostly for weekend services.

* If an Energy Audit has been conducted, please provide a copy.

Fire up stove 1-2 days before church service.
Heater is turned off during weekdays.

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply)

- ☑ ~~Heat plant in one~~ location: ☐ on ground level ☐ below ground level ☐ mezzanine ☐ roof ☐ at least 1 exterior wall
- ~~☐ Different heating plants~~ in different locations: How many? ______ What level(s)? ______
- ☒ Individual room-by-room heating systems (space heaters) → One toyo stove
- ~~☐ Is boiler room accessible to delivery trucks? ☐ Yes ☐ No~~ None

HEAT DELIVERY (check all that apply)

- ☐ ~~Hot water: ☐ baseboard~~ ☐ radiant heat floor ☐ cabinet heaters ☐ air handlers ☐ radiators ☐ other: ______
- ~~☐ Steam:~~ ______
- ☐ ~~Forced/ducted~~ air
- ☐ ~~Electric heat: ☐ resistance~~ ☐ boiler ☐ heat pump(s)
- ☒ Space heaters

HEAT GENERATION (check all that apply)

						Heating capacity (Btuh / kWh)	Annual Fuel Consumption	Cost
~~☐ Hot water boiler~~:	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
~~☐ Steam boiler~~:	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
~~☐ Warm air furnace~~:	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
~~☐ Electric resistance~~:	☐ baseboard	☐ duct coils						
~~☐ Heat pumps~~:	☐ air source	☐ ground source	☐ sea water					
☒ Space heaters:	☐ woodstove	☒ Toyo/Monitor	☐ other: ______			40,000 Btu/hr	Not Provided	$7.66/gal

TEMPERATURE CONTROLS (type of system; check all that apply)

- ☒ Thermostats on individual devices/appliances; no central control system
- ☐ ~~Pneumatic control~~ system ~~Manufacturer:~~ ______ ~~Approx. Age:~~ ______
- ~~☐ Direct digital control~~ system ~~Manufacturer:~~ ______ ~~Approx. Age:~~ ______

Record Name Plate data for boilers (use separate sheet if necessary): Toyostove Laser 73, 40,000 Btu/hr
Heater off during site visit.

Describe locations of different parts of the heating system and what building areas are served:

One toyo stove serves whole bldg.

Describe age and general condition of existing equipment:

Appears to be in good working order. Age unknown.

Who performs boiler maintenance? Marvin Ballata Describe any current maintenance issues: None.

No routine maintenance is performed

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):

None.

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

One 55-gal drum located to east of bldg. No spill containment.

If this fuel is also used for other purposes, please describe: Only for heating.

DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER
Check all that apply:

- ☒ Lavatories
- ☐ Kitchen
- ☐ Showers
- ☐ Laundry
- ☐ Water treatment
- ☐ Other: ______

None

TYPE OF SYSTEM
Check all that apply:

- ☐ Direct-fired, single tank
- ☐ Direct-fired, multiple tanks
- ☐ Indirect , using heating boiler with separate storage tank
- ☐ Hot water generator with separate storage tank
- ☐ Other: ______

~~What fuels are used to~~ generate hot water? (Check all that apply): ☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☐ #2 fuel oil

~~Describe location of water heater~~(s): ______

~~Describe on-site fuel storage: n~~umber of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

BUILDING ENVELOPE 48' x 36' ≅ 1,750 SF

Wall type (stick frame, masonry, SIP, etc.): 2x6 wood stud Insulation Value: R-19

Roof type: Cold Roof, Insulation unknown. Insulation Value: R-25

Windows: ☐ single pane ☒ double pane ☐ other: ______

Arctic entry(s): ☐ none ☒ at main entrance only ☐ at multiple entrances ☐ at all entrances

Drawings available: ~~☐ architectural ☐ mechanical ☐ electrical~~ None

Outside Air/Air Exchange: ~~☐ HRV ☐ CO_2 Sensor~~ None

ELECTRICAL

Utility company that serves the building or community: INNEC

Type of grid: ☐ building stand-alone ☒ village/community power ☐ railbelt grid

Energy source: ☒ hydropower ☒ diesel generator(s) ☐ Other: ______

Electricity rate per kWh: $0.98 Demand charge: None

Electrical energy phase(s) available: ☒ single phase ☐ 3-phase

Back-up generator on site: ☐ Yes ☒ No ~~If Yes, provide output capacity:~~ ______

Are there spare circuits in MDP and/or electrical panel?: ☒ Yes ☐ No

Record MDP and electrical panel name plate information: No main disconnect breaker. Just 13 breakers at main panel. Only one panel.

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $Unknown/ton Viable fuel source? Yes No Research in Progress
- Wood chip cost delivered to facility $Unknown/ton Viable fuel source? Yes No Research in Progress
- Cord wood cost delivered to facility $260/cord Viable fuel source? (Yes) No
- Distance to nearest wood pellet and wood chip suppliers? Must be shipped in.- FAIRBANKS/JUNEAU
- Can logs or wood fuel be stockpiled on site or at a nearby facility? There is limited space onsite.

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other: SEE REPORT, SECTION VII; CITY LAND, KIJIK LAND, STATE LAND, NPS

City land, Kijik land, State Land, NPS.

FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? One small driveway connects main entrance to road. There is not a lot of room due to bldg being on hillside.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)?

There is the old church just adjacent to east of building.

What are local soil conditions? Permafrost issues?

Gravel. Permafrost is here.

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?

Ambulance Garage, Clinic, Community bldg, and post office. See site dwg.

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?

Addition would be necessary. There is limited room onsite. Maybe to the west side.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?

New water line would be needed. Power from Poles.

If necessary, can piping be run underground from a central plant to the building? Where would piping enter boiler room?

Piping could be buried.

OTHER INFORMATION

Provide any other information that will help describe the space heating and domestic hot water systems, such as

- Is heat distribution system looping or branching? N/A
- For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? N/A
- Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source? None
- Any systems that could be added to the boiler system? N/A
- Are heating fuel records available? → Yes. Charolette is collecting them.

PICTURE / VIDEO CHECKLIST

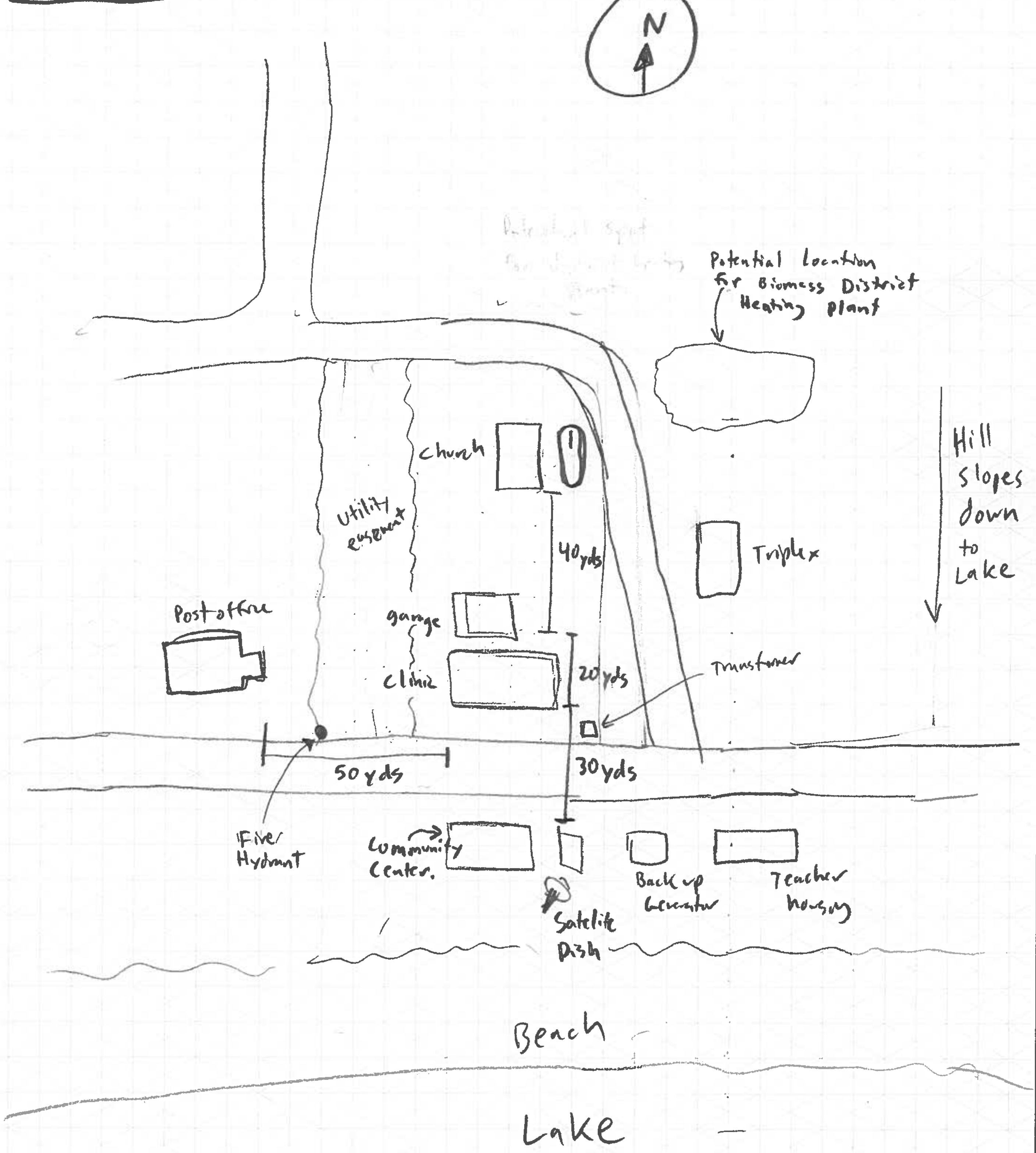
Exterior

- X Main entry
- X Building elevations
- X Several near boiler room and where potential addition/wood storage and/or exterior piping may enter the building
- X Access road to building and to boiler room
- X Power poles serving building
- X Electrical service entry
- X Emergency generator

Interior

- X Boilers, pumps, domestic water heaters, heat exchangers – all mechanical equipment in boiler room and in other parts of the building.
- X Boiler room piping at boiler and around boiler room
- X Piping around domestic water heater
- X MDP and/or electrical panels in or around boiler room
- X Pictures of available circuits in MDP or electrical panel (open door).
- X Picture of circuit card of electrical panel
- X Picture of equipment used to heat room in the building (i.e. baseboard fin tube, unit heaters, unit ventilators, air handler, fan coil)
- X Pictures of any other major mechanical equipment
- X Pictures of equipment using fuel not part of heating or domestic hot water system (kitchen equip., lab equip., pool, etc.)
- X Pictures of building plans (site plan, architectural floor plan, mechanical plan, boiler room plan, electrical power plan)

Site Plan



COFFMAN ENGINEERS

project	Nondalton Biomass	by	LJB	sheet no.
location	Nondalton, AK	date	4/25/13	
client	FEDC	checked		Job no. 13239
		date		

ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)

PRE-FEASIBILITY ASSESSMENT **FIELD DATA SHEET**

APPLICANT:	Nondalton Tribal Council		
Eligibility: (check one)	[X] Local government ☐ State agency ☐ Federal agency ☐ School/School District ☐ Federally Recognized Tribe ☐ Regional ANCSA Corp. ☐ Village ANCSA Corp. ☐ Not-for-profit organization ☐ Private Entity that can demonstrate a Public Benefit ☐ Other (describe):		
Contact Name:	William Evanoff		
Mailing Address:	P.O. Box 49		
City:	Nondalton		
State:	AK	**Zip Code:**	99640
Office phone:	(907) 294-2257	**Cell phone:**	( )
Fax:	(907) 294-2271		
Email:	ntcnahasda@yahoo.com		

Facility Identification/Name:	Community Building	
Facility Contact Person:	William Evanoff	
Facility Contact Telephone:	(907) 294-2257	( )
Facility Contact Email:	ntcnahasda@yahoo.com	

Charolette Ballutu 294-2288

SCHOOL/FACILITY INFORMATION (complete separate Field Data Sheet for each building)

SCHOOL FACILITY (Name: N/A **)**

School Type: (check all that apply)	[ ] Pre-School [ ] Elementary [ ] Middle School	[ ] Junior High [ ] High School [ ] Campus	[ ] Student Housing [ ] Pool [ ] Gymnasium	[ ] Other (describe):
Size of facility (sq. ft. heated):		Year built/age:		
Number of floors:		Year(s) renovated:		
Number of bldgs.:		Next renovation:		
# of Students:		Has en energy audit been conducted?:		If Yes, when? *

OTHER FACILITY (Name: Community Building **)**

Type:	[ ] Health Clinic [ ] Public Safety Bldg. [X] Community Center	[ ] Water Plant [ ] Washeteria [ ] Public Housing	[ ] Multi-Purpose Bldg [ ] District Energy System [ ] Other (list):
Size of Facility (sq. ft. heated)	2,000 SF	Year built/age:	1995 / 18 yrs
Number of floors:	1	Year(s) renovated:	Windows + Doors – 2011 – Part of Energy Audit
Number of bldgs.:	1	Next renovation:	Depends on Funding
Frequency of Usage:	50 hrs/wk	# of Occupants	2 workers, 5-10 community/day + classes + potlucks 30-100 people
Has an energy audit been conducted?	Yes	If Yes, when? *	

No one could find copy.

* If an Energy Audit has been conducted, please provide a copy.

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply)

- ☐ ~~Heat plant in one location:~~ ☒ ~~on ground level~~ ☐ ~~below ground level~~ ☐ ~~mezzanine~~ ☐ ~~roof~~ ☐ ~~at least 1~~ exterior wall
- ☐ ~~Different heating plants in different locations: How many? ______ What level(s)? ______~~
- ☒ Individual room-by-room heating systems (space heaters) → One monitor stove serves bldg.
- ☐ ~~Is boiler room accessible to delivery trucks? ☐ Yes ☐ No~~ — No Boiler Rm

HEAT DELIVERY (check all that apply)

- ☐ ~~Hot water~~: ☐ baseboard ☐ radiant heat floor ☐ cabinet heaters ☐ air handlers ☐ radiators ☐ other: ______
- ☐ ~~Steam:~~ ______
- ☐ ~~Forced/ducted~~ air
- ☐ ~~Electric heat: ☐ resistance~~ ☐ boiler ☐ heat pump(s)
- ☒ Space heaters

HEAT GENERATION (check all that apply)

						Heating capacity (Btuh / kWh)	Annual Fuel Consumption	Cost
☐ ~~Hot water boiler~~:	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil		~~28,500 gal~~	~~$3.40/gal~~
☐ ~~Steam boiler~~:	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
☐ ~~Warm air furnace~~:	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
☐ ~~Electric resistance~~:	☐ baseboard	☐ duct coils						
☐ ~~Heat pumps~~:	☐ air source	☐ ground source	☐ sea water					
☒ Space heaters:	☐ woodstove	☒ Toyo/Monitor	☐ other: ______			43,000 BTU/hr	Not Provided	$7.66/gal

TEMPERATURE CONTROLS (type of system; check all that apply)

- ☒ Thermostats on individual devices/appliances; no central control system
- ☐ ~~Pneumatic control system~~ ~~Manufacturer:~~ ______ ~~Approx. Age:~~ ______
- ☐ ~~Direct digital control system~~ ~~Manufacturer:~~ ______ ~~Approx. Age:~~ ______

Record Name Plate data for boilers (use separate sheet if necessary): Monitor 441, 43,000 BTU/hr, Heating Oil.

Describe locations of different parts of the heating system and what building areas are served:

A single Monitor stove serves the bldg.

Describe age and general condition of existing equipment:

Appears to be in good working order. Age unknown

Who performs boiler maintenance? Marvin Balluta Describe any current maintenance issues: None.

No routine maintenance is performed

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):

No hydronic piping.

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

One 500 gal tank serves monitor stove. Tank surrounded by shed. No containments

If this fuel is also used for other purposes, please describe:

Only for heating.

DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER
Check all that apply:

- [X] Lavatories
- [X] Kitchen
- ~~☐ Showers~~
- ~~☐ Laundry~~
- ~~☐ Water treatment~~
- ~~☐ Other:~~ ______

TYPE OF SYSTEM
Check all that apply:

- ☐ Direct-fired, single tank
- ☐ Direct fired, multiple tanks
- ☐ Indirect , using heating boiler with separate storage tank
- ☐ Hot water generator with separate storage tank
- [X] Other: Electric Hot water Heater

What fuels are used to generate hot water? (Check all that apply): ☐ natural gas ☐ propane [X] electric ☐ #1 fuel oil ☐ #2 fuel oil

Describe location of water heater(s): 80 gal electric Water heater is located in food storage Rm adjacent to the Kitchen.

Describe on-site fuel storage: number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
None. electric

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.): 2x6 wood stud. Insulation Value: R-19

Roof type: Cold roof. Insulation unknown. Insulation Value: R-25

Windows: ☐ single pane [X] double pane ~~☐ other:~~ → New double pane windows installed 2011 or 2012.

Arctic entry(s): ☐ none [X] at main entrance only ☐ at multiple entrances ☐ at all entrances

Drawings available: ~~☐ architectural ☐ mechanical ☐ electrical~~ None

Outside Air/Air Exchange: ~~☐ HRV ☐ CO_2 Sensor~~ None

ELECTRICAL

Utility company that serves the building or community: INNEC

Type of grid: ☐ building stand-alone [X] village/community power ☐ railbelt grid

Energy source: [X] hydropower [X] diesel generator(s) ☐ Other: ______

Electricity rate per kWh: $0.56 Demand charge: None

Electrical energy phase(s) available: [X] single phase ☐ 3-phase

Back-up generator on site: ☐ Yes [X] No ~~If Yes, provide output capacity~~: ______

Are there spare circuits in MDP and/or electrical panel?: [X] Yes ☐ No

Record MDP and electrical panel name plate information: 240V, 1φ, 100 Amp service. Served by Power lines.

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $ unknown /ton Viable fuel source? Yes No Research in Progress
- Wood chip cost delivered to facility $ unknown /ton Viable fuel source? Yes No Research in Progress
- Cord wood cost delivered to facility $ 260 /cord Viable fuel source? (Yes) No
- Distance to nearest wood pellet and wood chip suppliers? Shipped in from distributor – FAIRBANKS/JUNEAU
- Can logs or wood fuel be stockpiled on site or at a nearby facility? There is limited space around the bldg.

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other:
SEE REPORT, SECTION VII; CITY LAND, KIJIK CORP, STATE LAND, NATIONAL PARK LAND
City land, Kijik Corp. (Village Corp.), State Land, National Park Land.

FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? Yes. Bldg right by road.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)? There is a communication connex + satelite dish to the east. And to the south the land slopes sharply to the lake front.

What are local soil conditions? Permafrost issues?

Gravel. Permafrost is here.

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close? There are 4 bldgs. Clinic, Post Office, Garage for Ambulance, St. Nicolas Church. Also a triplex + teacher hou

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?

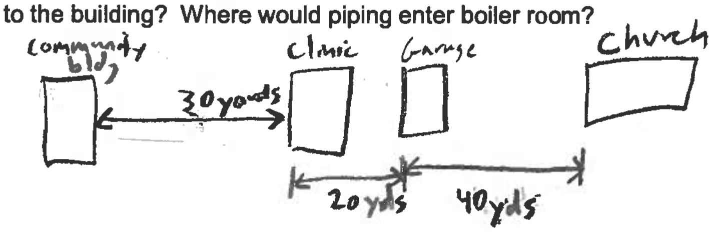
New building required. Unfortunately there is limited space around the bldg.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?

Could come from bldg.

If necessary, can piping be run underground from a central plant to the building? Where would piping enter boiler room?

Piping could be buried.



OTHER INFORMATION

Provide any other information that will help describe the space heating and domestic hot water systems, such as

Is heat distribution system looping or branching? N/A
For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? N/A
Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source? Electric Range
Any systems that could be added to the boiler system? N/A
Are heating fuel records available? Yes, Charollette is getting them.

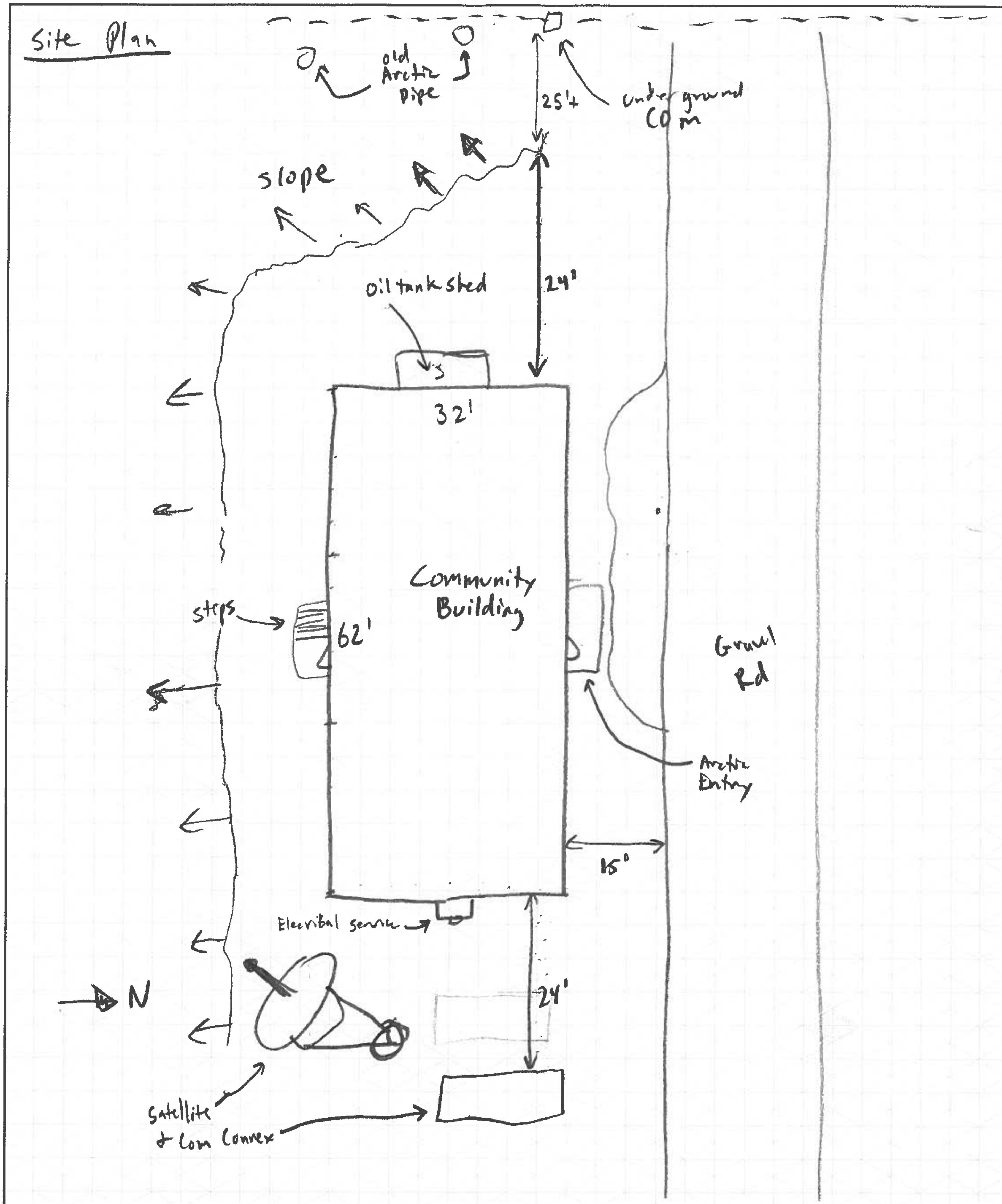
PICTURE / VIDEO CHECKLIST

Exterior

- X Main entry
- X Building elevations
- X Several near boiler room and where potential addition/wood storage and/or exterior piping may enter the building
- X Access road to building and to boiler room
- X Power poles serving building
- X Electrical service entry
- X Emergency generator

Interior

- X Boilers, pumps, domestic water heaters, heat exchangers – all mechanical equipment in boiler room and in other parts of the building.
- X Boiler room piping at boiler and around boiler room
- X Piping around domestic water heater
- X MDP and/or electrical panels in or around boiler room
- X Pictures of available circuits in MDP or electrical panel (open door).
- X Picture of circuit card of electrical panel
- X Picture of equipment used to heat room in the building (i.e. baseboard fin tube, unit heaters, unit ventilators, air handler, fan coil)
- X Pictures of any other major mechanical equipment
- X Pictures of equipment using fuel not part of heating or domestic hot water system (kitchen equip., lab equip., pool, etc.)
- X Pictures of building plans (site plan, architectural floor plan, mechanical plan, boiler room plan, electrical power plan)



COFFMAN ENGINEERS

project	Nondalton Biomass	by LJB	sheet no.
location	Nondalton, AK	date 4/25/13	
client	FEDC	checked	Job no. 13239
		date	

Population 230 in winter. 400 in Summer.

Wood

How much local wood availability is there? Wood is available. However, it is unknown how much wood can be sustainably harvested from the area.

Will additional wood demand cause issues? Almost all houses the Nondalton have wood stoves for heat + backup heat. It is not clear whether or not additional wood demand will be an issue.

Where would wood storage and wood drying occur: Adjacent to the bldg.

Typical Wind Direction at Storage Area: North + East.

Local Wood Species (Birch, Spruce): Birch, Dry Wood (Dead Spruce)

Moisture Content of Wood (Wet, dry, MC%): (dry circled)

Domestic Hot Water

Avg DHW Usage (ASHRAE Daily Avg for Office Bldg is 1.0 gal/day): Depends on Bldg.

Logistics

How are construction materials shipped to Village (barge company):

1. Desert Air ($5,000 for 7000 lbs freight (Plane Load))
2. Barge to IL, drive to 6 mile Lake, then barge to Nondalton

IDC for Trucks + Barge.

Leon Allsworth has barge

Is there local gravel or fill? How far away?

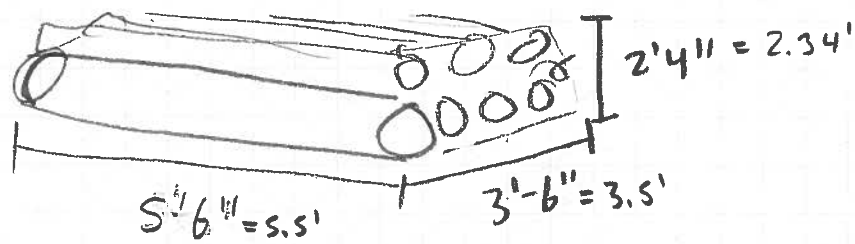
Local gravel pit within one mile of Bldg.

Fuel: Everetts flies fuel into village.

Barge Transport = Homer →(Barge)→ Williamsport →(Truck)→ Pile Bay →(Barge)→ Iliamna →(Truck)→ Fish Camp →(Barge)→ Nondalton.

Nondalton

$80 - $100 / ~~for~~ pile



Logs are 8" dia to 4" dia

$$(5.5')(3.5')(2.34')\left(\frac{1\text{ cord}}{128\text{ ft}^3}\right) = 0.35\text{ cords}$$

$$\frac{\$100}{0.35\text{ cords}} = \$286/\text{cord}$$

$$\frac{\$80}{0.35\text{ cords}} = \$228/\text{cord}$$

Avg price = $260/cord

COFFMAN ENGINEERS	project: Nondalton Biomass	by: LJB	sheet no.
	location: Nondalton, AK	date: 4/25/13	Job no. 13239
	client: FEDC	checked	
		date	

INNEC – Bob Tracy (on board of Elect Coop.)

- 98% Hydro – 100% Hydro.
- Diesels only run in emergency
- Nondalton school got electric boilers in 2011 to offset. Put in because they had excess hydropower.
- 571-1259 George Hornberger
- 20,000 – 25,000 gal deisel offset by ↑

- The village had looked into biomass a couple years ago and determined it wasn't feasible due to land issues regarding how to legally obtain wood, and who would cut, load, and maintain a system.

- There are not journeyman plumbers or heating contractors in Nondalton. Skilled Maintenance personel for complex mechanical system is an issue, as there are none in the village.

COFFMAN ENGINEERS	project Nondalton Biomass	by LJB	sheet no.
	location Nondalton, AK	date 4/25/13	Job no. 13239
	client FEDC	checked	
		date	

ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)

PRE-FEASIBILITY ASSESSMENT **FIELD DATA SHEET**

APPLICANT:	Nondalton Tribal Council
Eligibility: (check one)	☒ Local government ☐ State agency ☐ Federal agency ☐ School/School District ☐ Federally Recognized Tribe ☐ Regional ANCSA Corp. ☐ Village ANCSA Corp. ☐ Not-for-profit organization ☐ Private Entity that can demonstrate a Public Benefit ☐ Other (describe):
Contact Name:	William Evanoff
Mailing Address:	P.O. Box 49
City:	Nondalton
State:	AK **Zip Code:** 99640
Office phone:	(907) 294-2257 **Cell phone:** ( )
Fax:	(907) 294-2271
Email:	ntcnahasda@yahoo.com

Facility Identification/Name:	Tribal Office Building	
Facility Contact Person:	William Evanoff	
Facility Contact Telephone:	(907) 294-2257	( )
Facility Contact Email:	ntcnahasda@yahoo.com	

SCHOOL/FACILITY INFORMATION (complete separate Field Data Sheet for each building)

SCHOOL FACILITY (Name: N/A **)**

School Type: (check all that apply)	[ ] Pre-School [ ] Elementary [ ] Middle School	[ ] Junior High [ ] High School [ ] Campus	[ ] Student Housing [ ] Pool [ ] Gymnasium	[ ] Other (describe):
Size of facility (sq. ft. heated):		Year built/age:		
Number of floors:		Year(s) renovated:		
Number of bldgs.:		Next renovation:		
# of Students:		Has en energy audit been conducted?:		If Yes, when? *

OTHER FACILITY (Name: Tribal Office Building **)**

Type:	[ ] Health Clinic [ ] Public Safety Bldg. [ ] Community Center	[ ] Water Plant [ ] Washeteria [ ] Public Housing	[ ] Multi-Purpose Bldg [ ] District Energy System [X] Other (list): Office Bldg
Size of Facility (sq. ft. heated)	2,200 SF	Year built/age:	1991 / 22 yrs Old
Number of floors:	2	Year(s) renovated:	2011
Number of bldgs.:	One	Next renovation:	2nd flor - Two more offices.
Frequency of Usage:	50 hrs	# of Occupants	4-5 Avg. 10 max.
Has an energy audit been conducted?	No	If Yes, when? *	—

* If an Energy Audit **has** been conducted, please provide a copy.

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply)

~~☐ Heat plant in one location: ☐ on ground level~~ ☐ below ground level ☐ mezzanine ☐ roof ☐ at least 1 exterior wall

☒ Different heating plants in different locations: How many? 2 What level(s)? 2 monitors on Ground flr.

☒ Individual room-by-room heating systems (space heaters) → electric space heaters on second flr.

~~☐ Is boiler room accessible to delivery trucks? ☐ Yes~~ ☐ No No Boiler Rm.

HEAT DELIVERY (check all that apply)

~~☐ Hot water: ☐ baseboard~~ ☐ radiant heat floor ☐ cabinet heaters ☐ air handlers ☐ radiators ☐ other: ______

~~☐ Steam:~~ ______

~~☐ Forced/ducted air~~

☒ Electric heat: ☐ resistance ☐ boiler ☐ heat pump(s) ☒ Individual Electric Space heaters for some second floor offices. (2 space heaters)

☒ Space heaters

HEAT GENERATION (check all that apply)

						Heating capacity (Btuh / kWh)	Annual Fuel Consumption	Cost
~~☐ Hot water boiler:~~	☐ natural gas	☐ propane	☐ electric	☒ #1 fuel oil	☐ #2 fuel oil		38,800 gal	$5.40/gal
~~☐ Steam boiler:~~	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
~~☐ Warm air furnace:~~	☐ natural gas	☐ propane	☐ electric	☐ #1 fuel oil	☐ #2 fuel oil			
☒ Electric resistance:	☐ baseboard	☐ duct coils	☒ Space Heaters					
~~☐ Heat pumps:~~	☐ air source	☐ ground source	☐ sea water					
☒ Space heaters:	☐ woodstove	☒ Toyo/Monitor	☐ other: 37,200 +			40,000 Btu/hr	Not Provided	$7.66/gal

TEMPERATURE CONTROLS (type of system; check all that apply)

☒ Thermostats on individual devices/appliances; no central control system

~~☐ Pneumatic control system~~ ~~Manufacturer:~~ ______ ~~Approx. Age:~~ ______

~~☐ Direct digital control system~~ ~~Manufacturer:~~ ______ ~~Approx. Age:~~ ______

Record Name Plate data for boilers (use separate sheet if necessary) (1) Monitor 2400, 37,200 BTU/hr output
(2) Toyostove Laser 73, 40,000 BTU/hr output

Describe locations of different parts of the heating system and what building areas are served:
Monitor stove heats conference Rm on first floor. Toyostove heats old apartment on first floor that has been renovated to offices. No heat system serves second floor. only individual electric space heaters are used on second flr.

Describe age and general condition of existing equipment: Appears to be in okay shape. Age unknown.

Who performs boiler maintenance? Marvin Balluta Describe any current maintenance issues: No issues.
No routine maintenance is performed.

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):
No hydronic piping. Only plumbing for water for bathrooms.

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
2 tanks. 300 gal tank serves Monitor. 55 gal drum serves Toyo. No spill containment around tanks.

If this fuel is also used for other purposes, please describe: Just for heating.

DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER
Check all that apply:

- ☒ Lavatories
- ~~☐ Kitchen~~
- ☒ Showers → shower exists but is not used.
- ~~☐ Laundry~~
- ~~☐ Water treatment~~
- ~~☐ Other:~~ ____________

TYPE OF SYSTEM
Check all that apply:

- ☐ Direct-fired, single tank
- ☐ Direct fired, multiple tanks
- ☐ Indirect, using heating boiler with separate storage tank
- ☐ Hot water generator with separate storage tank
- ☒ Other: Electric Water Heaters

What fuels are used to generate hot water? (Check all that apply): ☐ natural gas ☐ propane ☒ electric ☐ #1 fuel oil ☐ #2 fuel oil

Describe location of water heater(s): There are 2 water heaters. A 30 gal Reliance serves the first floor bathroom, which is currently disconnected & not in service. A 50 gal Richmond serves the 2nd flr bathroom.

Describe on-site fuel storage: number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.: None. Electric units.

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.): 2x6 Wood stud Insulation Value: R-19

Roof type: Cold roof. Insulation could not be accessed Insulation Value: R-25

Windows: ☐ single pane ☒ double pane ☐ other: ____________

Arctic entry(s): ☐ none ☐ at main entrance only ☒ at multiple entrances ☐ at all entrances

~~Drawings available: ☐ architectural ☐ mechanical ☐ electrical~~ None

~~Outside Air/Air Exchange: ☐ HRV ☐ CO_2 Sensor~~ None

ELECTRICAL

Utility company that serves the building or community: INNEC

Type of grid: ☐ building stand-alone ☒ village/community power ☐ railbelt grid

Energy source: ☒ hydropower ☒ diesel generator(s) ☐ Other: ____________

Electricity rate per kWh: $0.56 Demand charge: None

Electrical energy phase(s) available: ☒ single phase ☐ 3-phase

Back-up generator on site: ☐ Yes ☒ No If Yes, provide output capacity: ——

Are there spare circuits in MDP and/or electrical panel?: ☒ Yes ☐ No

Record MDP and electrical panel name plate information: (1) 240 V, 1Φ, 200 Amp service for bldg. (2) A second service is not used. } → Power poles serve these

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $unknown/ton Viable fuel source? Yes No Research in Progress
- Wood chip cost delivered to facility $unknown/ton Viable fuel source? Yes No Research in Progress
- Cord wood cost delivered to facility $260/cord Viable fuel source? Yes No
- Distance to nearest wood pellet and wood chip suppliers? Must be shipped in fr Distributor. - FAIRBANKS JUNEAU
- Can logs or wood fuel be stockpiled on site or at a nearby facility? Yes

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other: SEE REPORT, SECTION VII; CITY LAND, KIJIK LAND, STATE LAND, NPS

N George Alexie (council Member & NPS employee) 444-5330. City land, Kijik land, state land, NPS.

FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? Yes. You can drive around bldg.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)? Brush exists.

What are local soil conditions? Permafrost issues?
Gravel. Permafrost exists here.

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?
None.

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?
A small system may be able to fit inside. But an addition or separate bldg would be better for space. It could be located to East of bldg.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?
Power Nearby power pole. Water from bldg.

If necessary, can piping be run underground from a central plant to the building? Where would piping enter boiler room?
Piping can be buried.

OTHER INFORMATION

Provide any other information that will help describe the space heating and domestic hot water systems, such as

- Is heat distribution system looping or branching? N/A
- For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? N/A
- Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source? None
- Any systems that could be added to the boiler system? None
- Are heating fuel records available? → Farm Silas has records.

PICTURE / VIDEO CHECKLIST

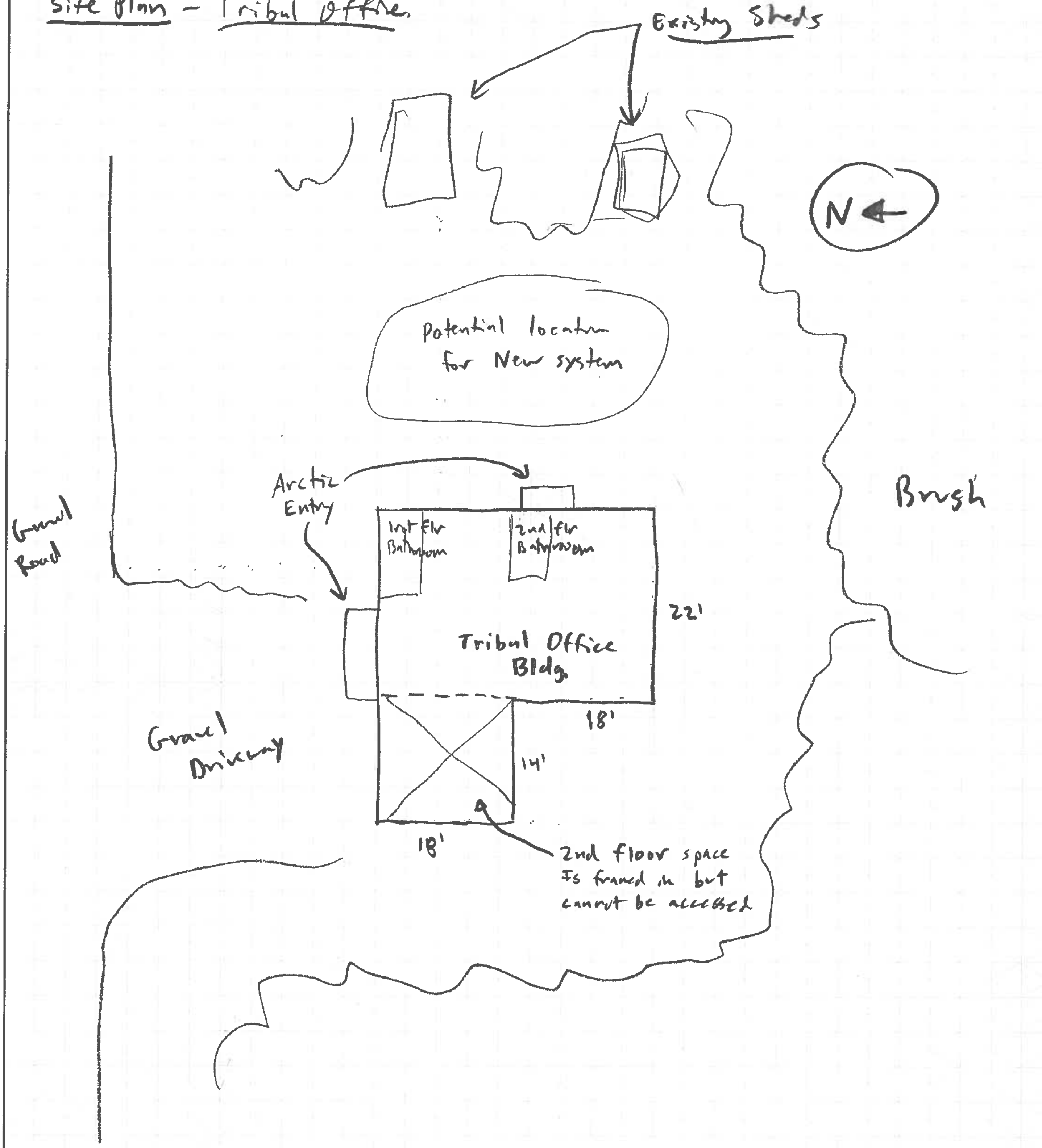
Exterior

- X Main entry
- X Building elevations
- X Several near boiler room and where potential addition/wood storage and/or exterior piping may enter the building — N/A
- X Access road to building and to boiler room
- X Power poles serving building
- X Electrical service entry
- X Emergency generator — None

Interior

- X Boilers, pumps, domestic water heaters, heat exchangers – all mechanical equipment in boiler room and in other parts of the building. — N/A
- X Boiler room piping at boiler and around boiler room - N/A
- X Piping around domestic water heater
- X MDP and/or electrical panels in or around boiler room
- X Pictures of available circuits in MDP or electrical panel (open door).
- X Picture of circuit card of electrical panel
- X Picture of equipment used to heat room in the building (i.e. baseboard fin tube, unit heaters, unit ventilators, air handler, fan coil)
- X Pictures of any other major mechanical equipment
- X Pictures of equipment using fuel not part of heating or domestic hot water system (kitchen equip., lab equip., pool, etc.) — N/A
- X Pictures of building plans (site plan, architectural floor plan, mechanical plan, boiler room plan, electrical power plan) - N/A

Site Plan – Tribal Office



COFFMAN ENGINEERS	project: Nondalton Tribal Office	by: LJB	sheet no.
	location: Nondalton, AK	date: 4/25/13	Job no. 13239
	client: FEDC	checked	
		date	